III. "On an Effect of Light upon Magnetism." By SHELFORD BIDWELL, M.A., F.R.S. Received March 11, 1889.

Several experimenters in the early part of the present century tried to magnetise iron and steel by the action of light,* but I do not know of any recent attempts in this direction, and of late years the thing has been generally regarded as impossible. Under ordinary circumstances there can be little doubt that this is the case, but, if a certain condition is fulfilled, we might, I think, expect to find some evidence of the action of radiation upon the magnetism of iron.

The condition is that the susceptibility of the bar AB to be operated upon shall be greater (or less) for a magnetic force in the direction AB than for an equal one in the direction BA. This paper contains a short preliminary account of a series of experiments which have been undertaken with iron bars having this property. Much yet remains to be done, which will require a considerable amount of time, and for which special apparatus must be constructed. In the meantime, the results already obtained appear to possess sufficient interest to justify their publication.

The method of preparing the bars is as follows: A piece of soft iron rod, which may conveniently be 10 or 12 cm. long and from 0·5 to 1 cm. in diameter, is raised to a bright yellow heat and slowly cooled. When cold, it is placed inside a solenoid, through which is passed a battery current of sufficient strength to produce a field of about 350 or 400 C.G.S. units. The iron when removed from the coil is found to be permanently magnetised, and its north pole is marked for the sake of distinction with red sealing-wax varnish. The bar is then supported horizontally and in an east and west direction behind a small reflecting magnetometer, and over it is slipped a coil, which is shunted with a rheostat, the resistance of which can be gradually increased from 0 to 26 ohms. The coil can be connected by a key with a single battery cell, which is so arranged as to produce a demagnetising force inside the coil. The resistance of the rheostat is slowly raised, so that more and more current passes through the coil, the battery key being alternately lifted and depressed until the magnetometer indicates that the iron bar as a whole is perfectly demagnetised. The strength of the demagnetising force required varies according to circumstances: it is generally about one-thirtieth or one-twenty-fifth of the original magnetising force.

After this treatment the iron rod does not differ, so far as ordinary tests will show, from one which has never been submitted to mag-

* Chrystal, 'Encycl. Britann.,' vol. 15, p. 274, mentions the following names:—Morichini, Mrs. Somerville, Christie, Riess, and Moser.

netic influences. Nevertheless, as is well known, it possesses certain properties which distinguish it from a piece of really virgin iron. In the first place, the magnetisation induced by a force acting in such a direction as to make the marked end a north pole, is greater than that caused by an equal force in an opposite direction. Again, if such a bar be held horizontally east and west (to avoid terrestrial influences), and tapped with a mallet, the marked end at once becomes a north pole. A similar effect follows if the rod be warmed in the flame of a spirit-lamp. Lastly, if it be placed inside a coil and subjected to the action of a series of rather feeble magnetic forces, of equal strength but alternating in direction, the marked end will generally become a north pole, even though the last of the alternate forces may have tended to induce the opposite polarity.

A rod treated as above described appears to be remarkably sensitive to the action of light. When such a rod is placed behind the magnetometer, and illuminated by an oxyhydrogen lamp about 70 cm. distant, there occurs an immediate deflection of from 10 to 200 scale divisions,* the magnitude of the effect varying in different specimens of iron. As the action of the light is continued, the deflection slowly increases. When the light is shut off, the magnetometer instantly goes back over a range equal to that of the first sudden deflection, then continues to move slowly in the backward direction towards zero.

The first quick movement I believe may be due to the direct action of radiation, and the subsequent slow movement to the gradually rising temperature of the bar. With a thick rod (1 cm. in diameter) the slow movement is barely perceptible, extending over only one or two scale divisions in the course of a minute, the spot of light becoming almost stationary after the first sudden jump. With a thin rod the sudden effect is generally smaller, while the slow after-effect is greater and may continue until the spot of light passes off the scale.

As a general rule the magnetic effect is such as to render the marked end of the rod a north pole: occasionally, however, it becomes a south pole, but in such cases I have always found that the polarity is comparatively feeble. It may even happen† that the marked end becomes north when certain portions of the rod are illuminated, and south when the light acts upon other portions. This is probably due to irregular annealing and a consequent local reversal of the direction of maximum susceptibility: it indicates that the light effect is local, and is confined to the illuminated surface. In one remarkable specimen, which happens not to have been annealed at all, the sudden effect and the slow effect are in opposite directions. When the light

* The magnetometer mirror was 1 metre distant from the scale and each division = 0·64 mm. ($\frac{1}{40}$ inch).

† This has been observed in two specimens.

is turned upon this rod, there is at first a sudden deflection of twenty magnetometer-scale-divisions to the left, the spot afterwards moving slowly and steadily towards the right. When the light is shut off there occurs at once a jump of twenty divisions further towards the right before the spot begins to move back in the zero direction.

Some attempts have been made to repeat the experiments with light polarised by means of a Nicol's prism; but, either because the largest prism at my disposal was too small (its aperture being barely 2 cm.), or because too much of the radiant energy was absorbed by the spar, I failed to get any magnetic effects whatever with the prism in either position.

[Professor Silvanus Thompson has quite recently been kind enough to lend me a very large and excellent Nicol's prism. From a few experiments already made with this instrument it appears that the action of the light is quite independent of the plane of polarisation.—March 16.]

There can be no doubt whatever of the reality of the effects here described: they are perfectly distinct, and are at any time reproducible with certainty. The only question is how much of them is primarily caused by the action of light, and how much by mere incidental change of temperature. But taking all the circumstances into consideration, I think the evidence is in favour of the conclusion that the *instantaneous* magnetic change, which occurs when a prepared iron bar is illuminated, is purely and directly an effect of radiation.

IV. "Recalescence of Iron." By J. HOPKINSON, F.R.S. Received March 7, 1889.

Professor Barrett has observed that if an iron wire be heated to a bright redness and then be allowed to cool, that this cooling does not go on continuously, but that after the wire has sunk to a very dull red it suddenly becomes brighter, and then continues to cool down. He surmised that the temperature at which this occurs is the temperature at which the iron ceases to be magnetisable. In repeating Professor Barrett's experiments, I found no difficulty in obtaining the phenomenon with hard steel wire, but I failed to observe it in the case of soft iron wire, or in the case of manganese steel wire. It appeared to be of interest to determine the actual temperature at which the phenomenon occurred, and also the amount of heat which was liberated. Although other explanations of the phenomenon have been offered, there can never, I think, have been much doubt that it was due to the liberation of heat owing to some change in the material, and not due to any change in the conductivity or emissive power. My method of experiment was exceedingly simple. I took a